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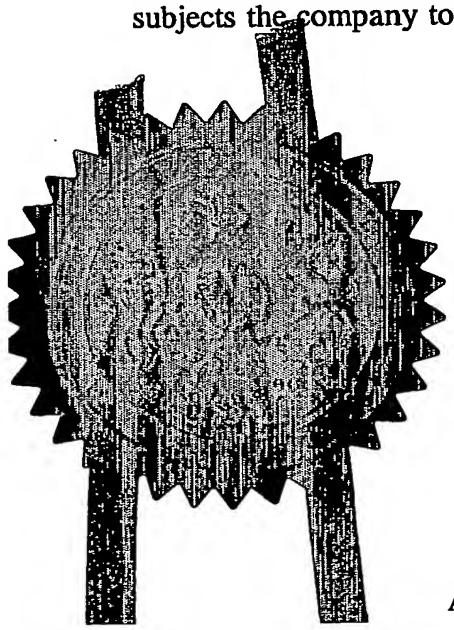

Signed

Dated 20 March 2003

Patents Form 1/77

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Cardiff Road
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NP9 1RH

P01/7700 0.00-0204927.8

Request for grant of a patent

1.	Your Reference	**PLB/CC/W150**
2.	Application number	**0204927.8** 01 MAR 2002
3.	Full name, address and postcode of the or each Applicant Country/state of incorporation (if applicable)	**Per-Tec Limited** **Manchester School of Engineering** **The University of Manchester** **Simon Building** **Oxford Road** **Manchester M13 9PL** 8093106001 **Incorporated in: England & Wales**
4.	Title of the invention	**Improvements In and Relating to Electrode Mounting Arrangements**
5.	Name of agent Address for service in the UK to which all correspondence should be sent Patents ADP number	**APPLEYARD LEES** **15 CLARE ROAD** **HALIFAX** **HX1 2HY** **190001**

6. Priority claimed to:	Country	Application number	Date of filing

7. Divisional status claimed from:	Number of parent application	Date of filing
	-	-

8.	Is a statement of inventorship and of right to grant a patent required in support of this application?	**YES**

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	16 x 2 /
Claim(s)	CF
Abstract	
Drawing(s)	8 x 2 /

10. If you are also filing any of the following, state how many against each item

Priority documents	
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Statement of inventorship and right to grant a patent (PF 7/77)	
Request for a preliminary examination and search (PF 9/77)	
Request for substantive examination (PF 10/77)	
Any other documents (please specify)	

11. We request the grant of a patent on the basis of this application.

Signature: **APPLEYARD LEES**

Date: **28 February 2002**

Appleyard Lees

12. Contact: **Paul Brandon – 0161 835 9655**

Fig 1

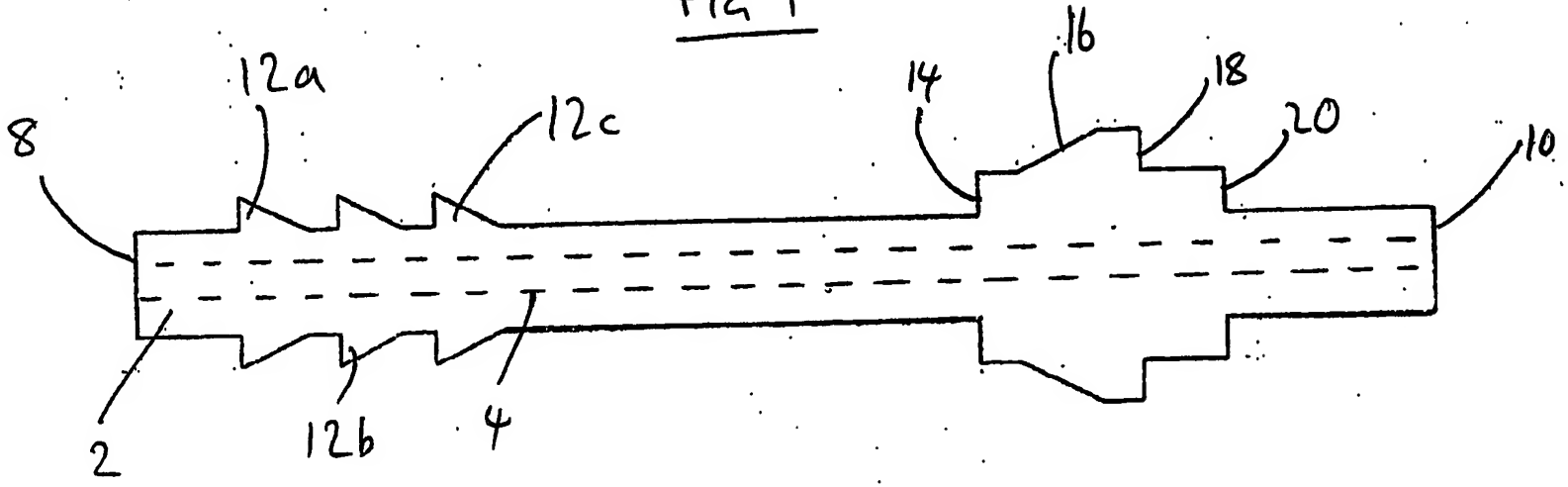


Fig 2

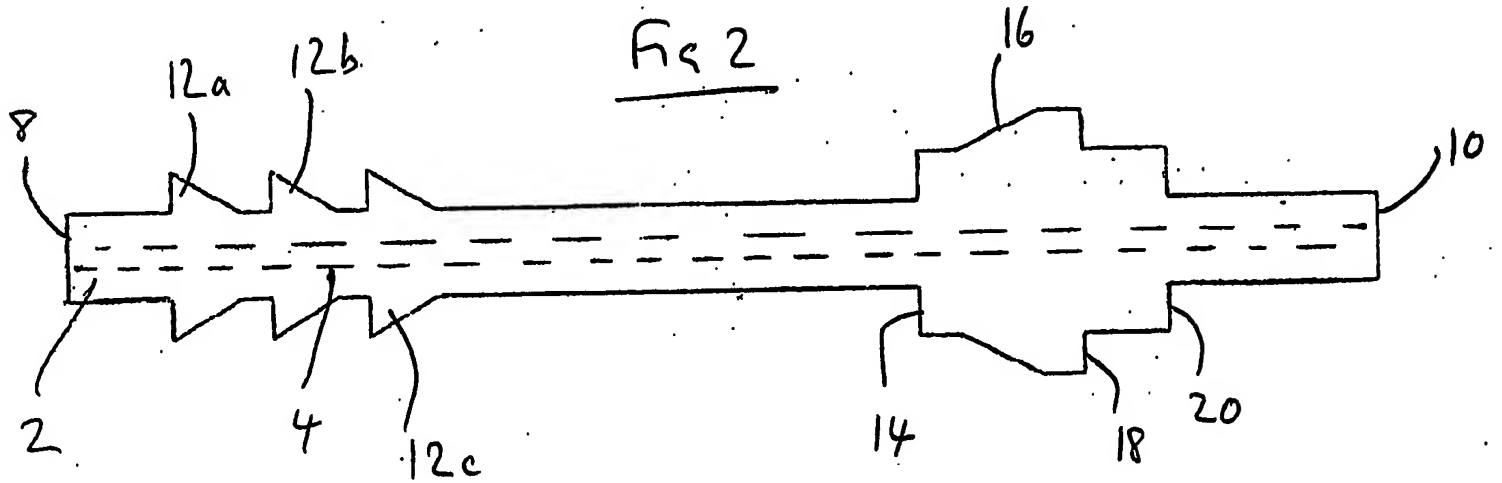


FIG 3

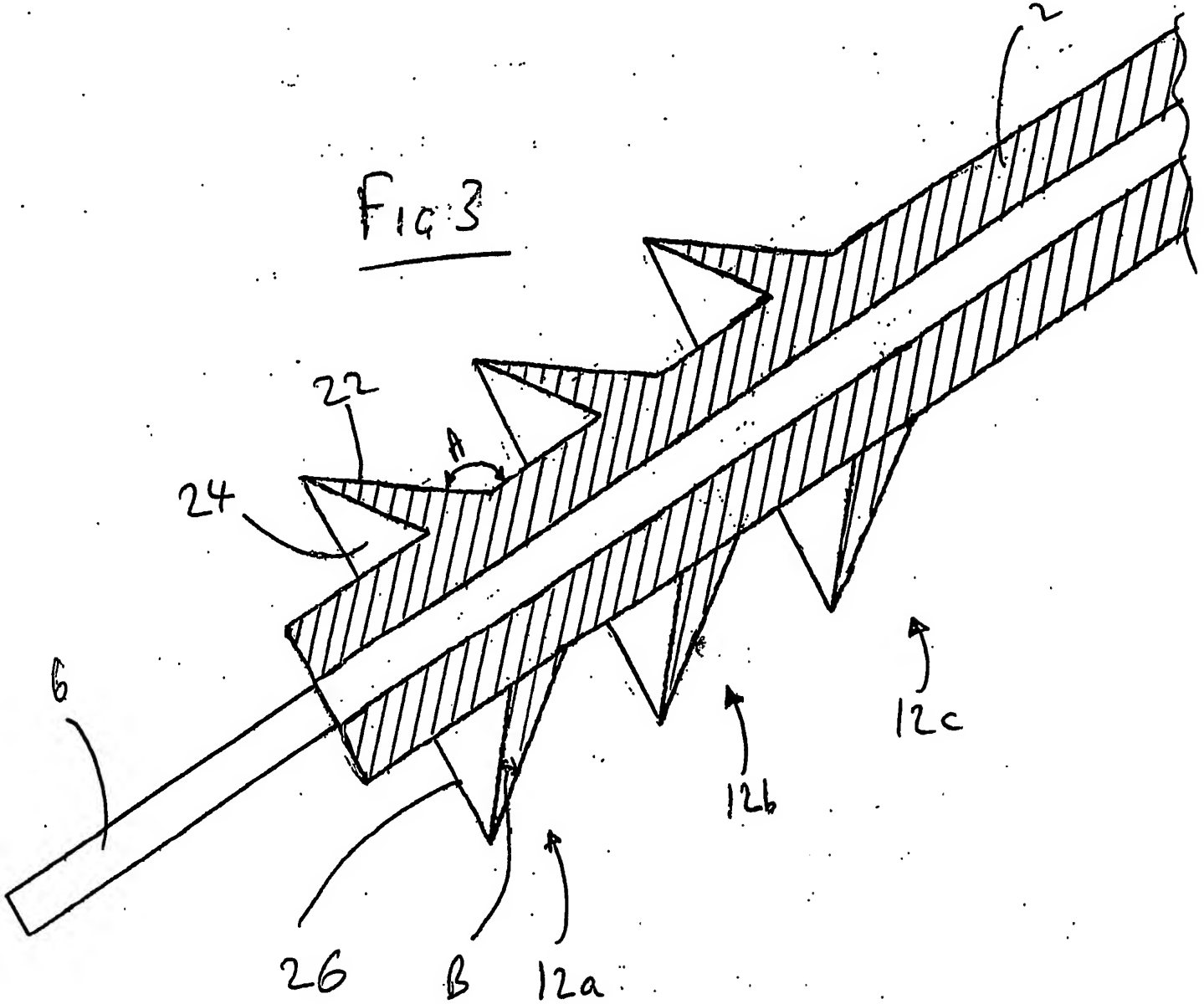


Figure 4

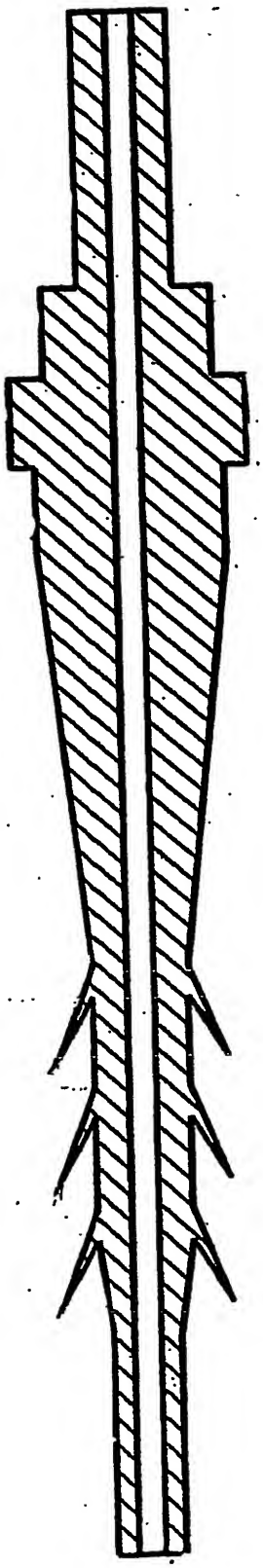


FIGURE 5

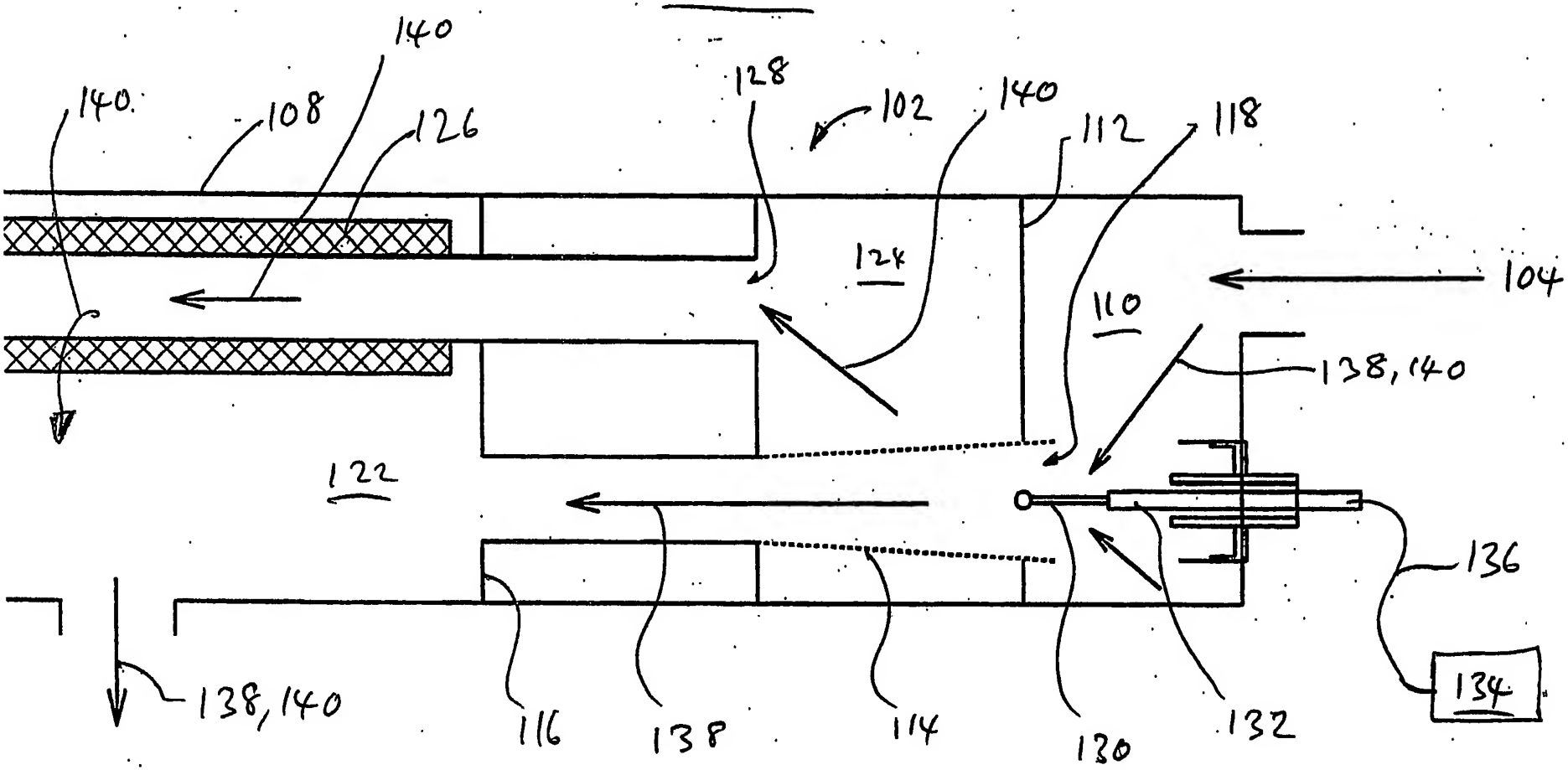

140
140
108
126
128
102
140
112
118
124
104
110
138, 140
122
136
134
138, 140
116
138
114
130
132

Fig 6

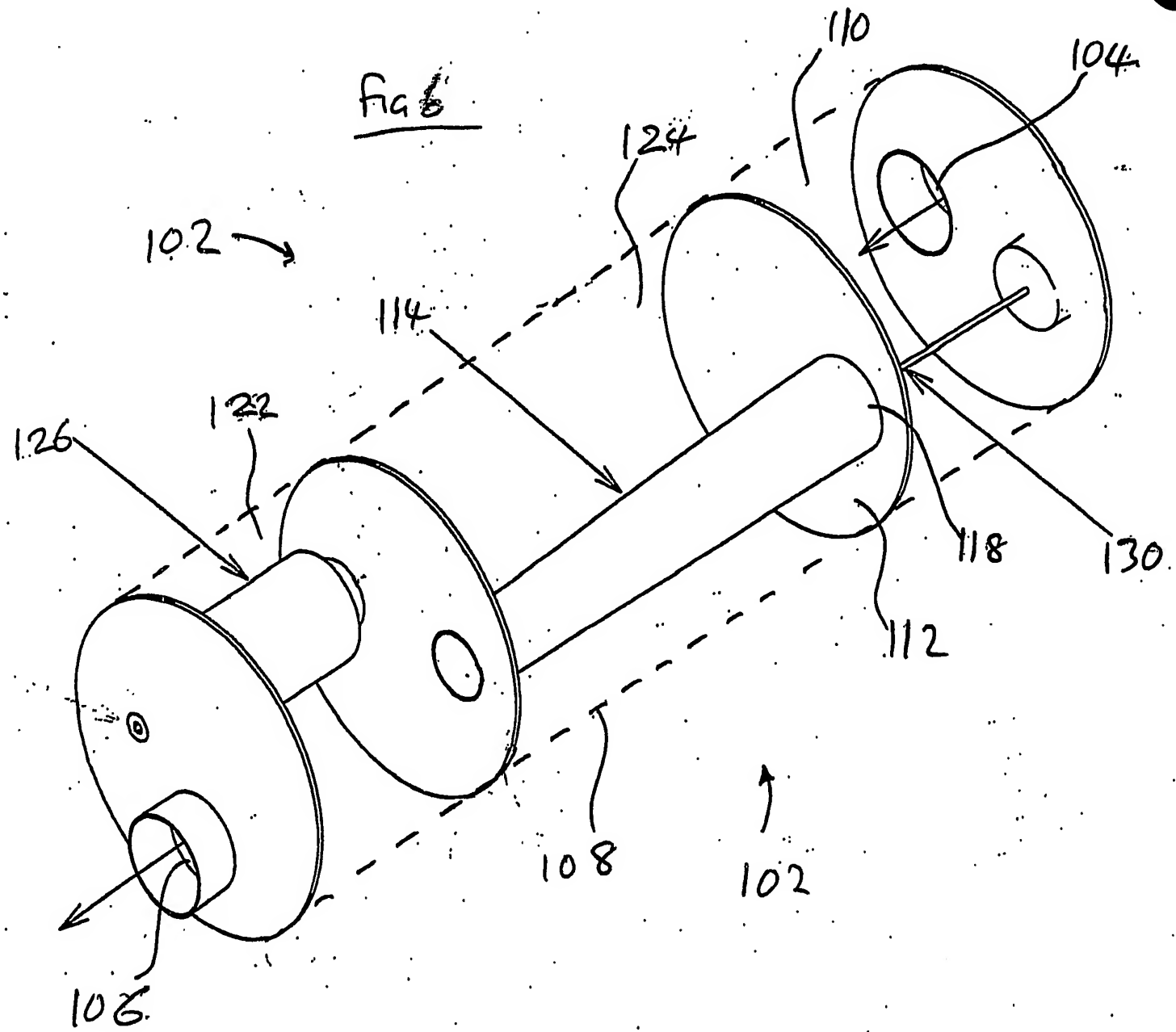
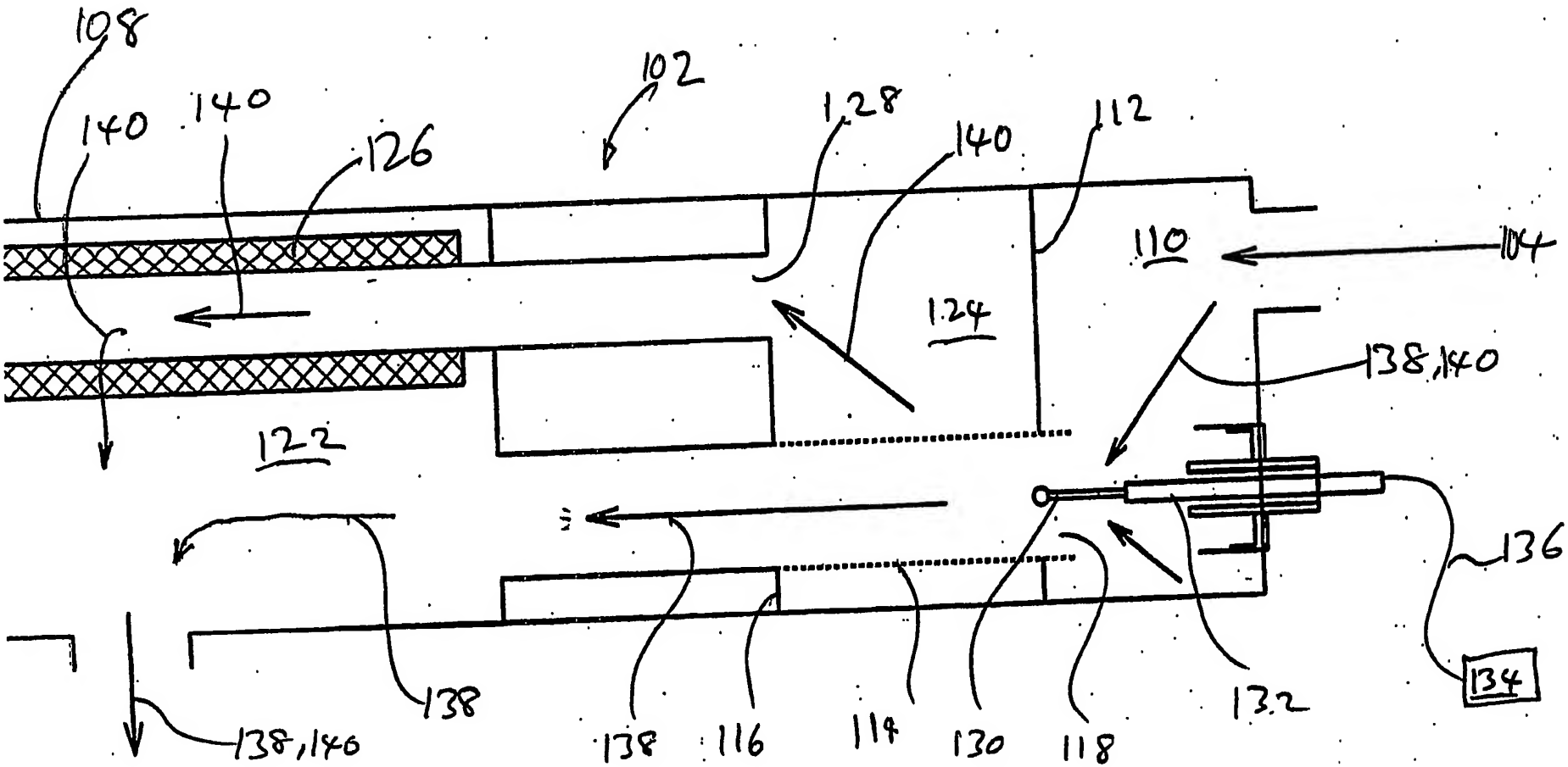


FIGURE 7


108
102
140
140
126
128
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112
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124
138,140
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136
138
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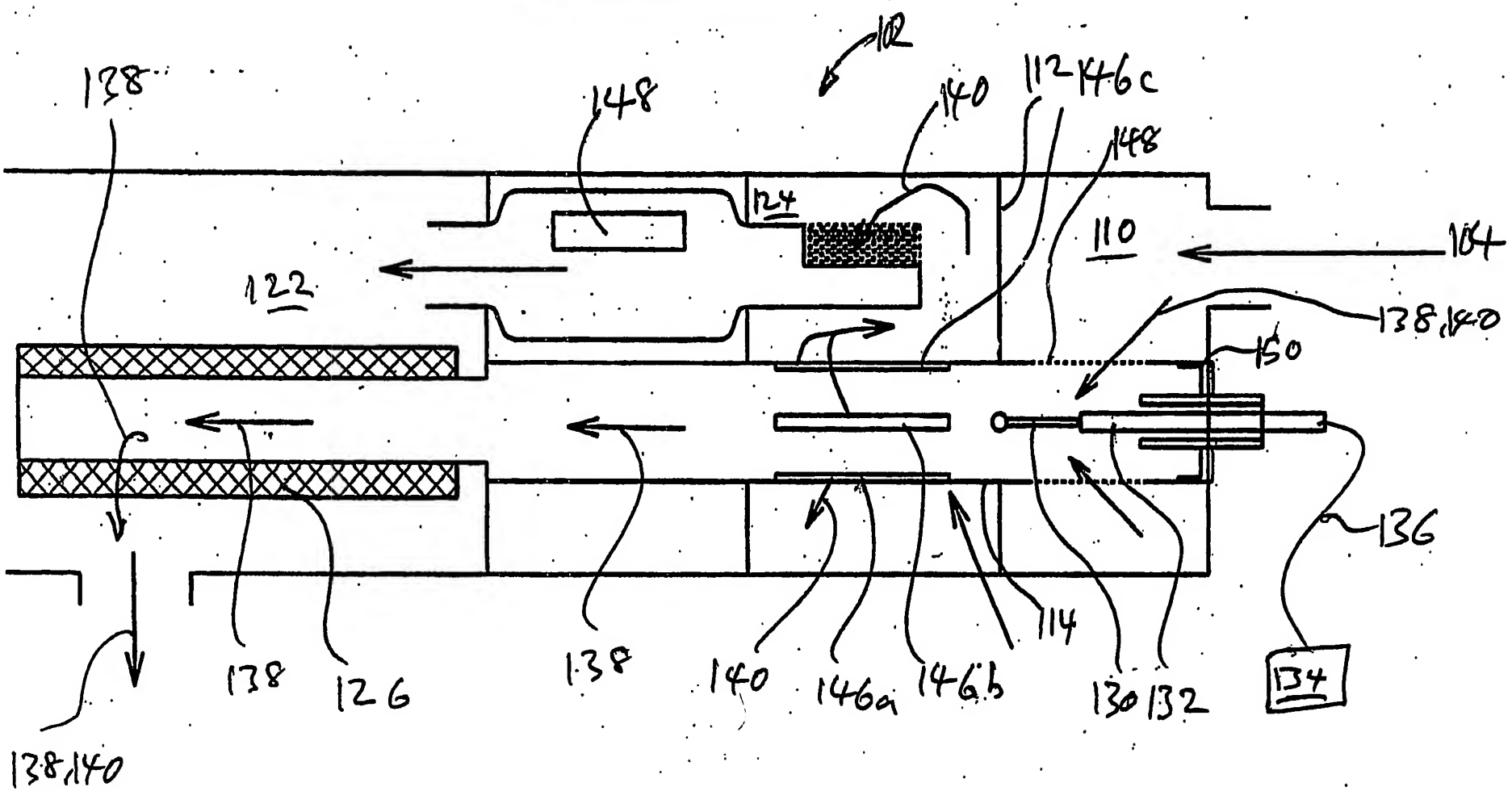
134
138,140
138
116
114
130
118

Figure 8


102
138
148
140
112
146c
148
124
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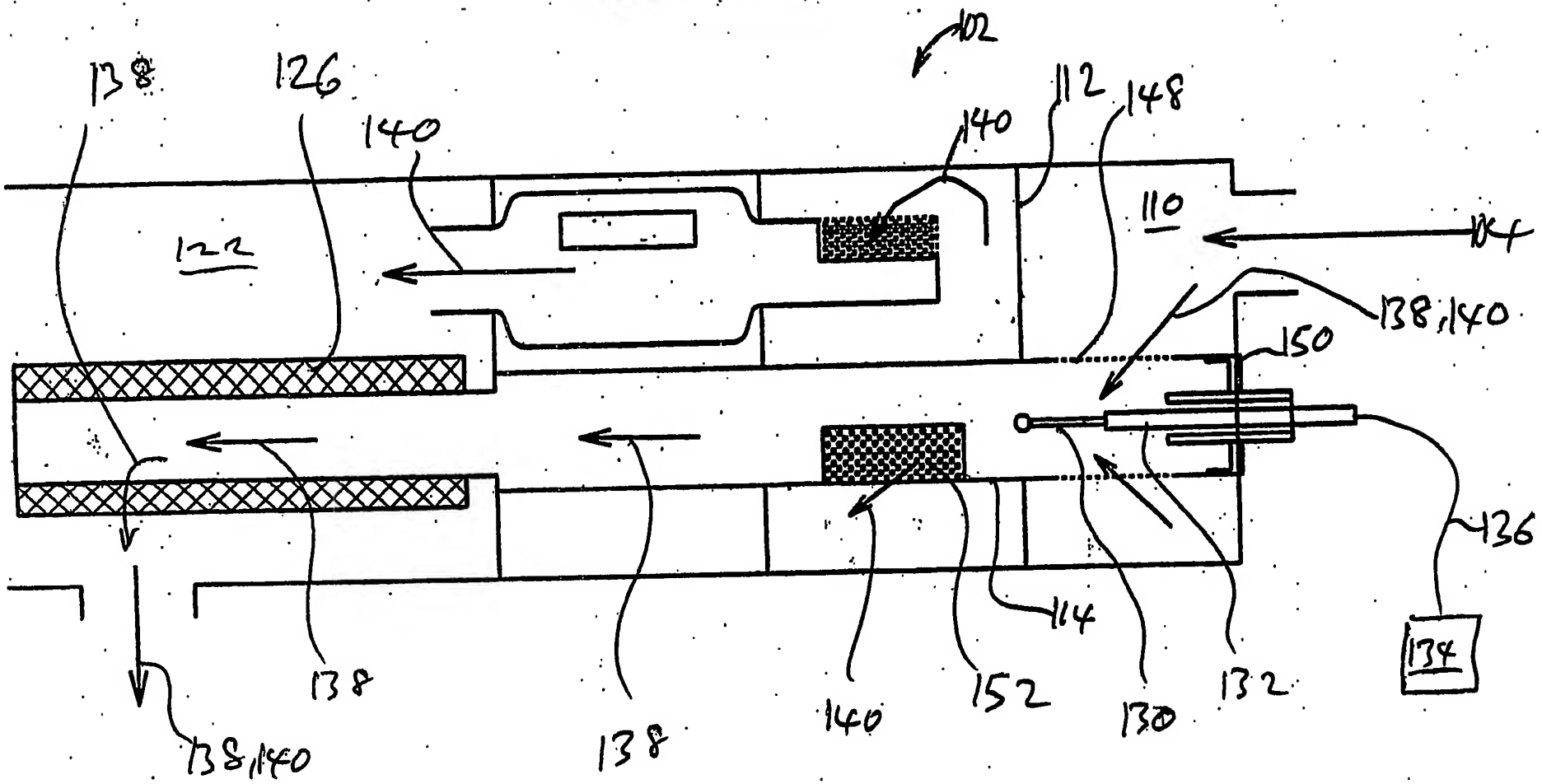
104
122
138,140
150
136
138
126
138
140
146a
146b
114
130
132
134
138,140

FIGURE 9


102
138
126
140
140
112
148
122
110
104
138,140
150
136
114
134
138
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152
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138,140
138

Improvements In and Relating to Electrode Mounting Arrangements

Field of the Invention

The present invention relates to mounting arrangements for electrodes and to pollutant removal systems incorporating the same. In particular, but without limitation, the present invention relates to mounting arrangements for electrodes used in the separation of pollutants, especially particulates from gas streams.

Background to the Invention

It is known to attempt to separate particulate pollutants from a gas stream by charging (ionising) the particulates, typically by corona discharge from an electrode and using the electro-static properties of the charged particulates to separate them from the gas flow stream. This is referred to as electrostatic precipitation.

The present inventor has found that while it is possible to operate such a system on a small scale for a short period of time, the performance of any such equipment degrades over time. It is believed that one reason for such degradation is the tendency of current to flow from the electrode to earth. Typically the nearest earth is the mounting bracket for the electrode support.

Preferred embodiments of the present invention aim to obviate or overcome disadvantages of the prior art, whether referred to herein or otherwise.

Summary of the Invention

According to the present invention in a first aspect, there is provided a mounting arrangement for an electrode, the mounting arrangement comprising a body with means for mounting an electrode, whereby in use the body is partly about the electrode and the electrode projects from the body, the arrangement further comprising at least one external protrusion on the body.

Such an arrangement provides a tortuous route for current from the electrode along the body thus reducing current leakage.

Suitably, the body is generally cylindrical and the projection is generally radial relative thereto.

Suitably, the at least one protrusion is annular (ie 360°) about the body.

Suitably, the body and the at least one protrusion are a one piece structure.

Suitably, the body at least partly comprises a high electrical resistance material. Suitably, that part of the body to be in contact with the electrode comprises a high electrical resistance material. A suitable high electrical resistance material is ceramic material

Suitably, the electrode mounting arrangement is suitable for a pollutant removal system.

Suitably, the arrangement comprises a section of or attached to the body which section comprises means for permitting the body to be mounted.

Suitably, the body is substantially circular cylindrical.

Suitably, the regions between the protrusions are substantially cylindrical.

Suitably, the at least one protrusion is generally conical externally. Suitably, the at least one protrusion is at least partly hollow. Suitably, the at least one protrusion is rebated. Suitably, the protrusions are tapered.

Suitably, all of the body comprises substantially the same material. This reduces manufacturing costs and helps minimise problems caused by differing thermal expansion coefficients for other materials.

Suitably, there are a plurality of protrusions spaced along the body. Suitably, the protrusions are substantially similar. Suitably, the protrusions are equally spaced along the body.

Suitably, the body is generally cylindrical .

Suitably, the body includes a hole therethrough for mounting an electrode therein. Suitably, the hole is longitudinal.

According to the present invention in a second aspect there is provided an electrode mounting arrangement comprising a mounting arrangement according to the first aspect of the invention, the arrangement further comprising an electrode about which the body is located.

Suitably, the electrode is mounted from one end only.

Suitably, the electrode projects from an end of the body for forming a corona discharge.

According to the present invention in a third aspect, there is provided an electrode mounting arrangement comprising a mounting arrangement according to the first or second aspects of the invention, the arrangement further comprising a mounting bracket about the section.

Suitably, the mounting bracket comprises a hard anodised metal. Suitably, the metal is aluminium.

According to the present invention in a fourth aspect, there is provided a pollutant removal system comprising an electrode mounting arrangement according to any preceding aspect of the invention.

Suitably, the system comprises means for diverting pollutants to a pollutant remover. In the case of particulate pollutants the remover may be a filter.

Suitably, the system comprising means for charging particulates in the gas stream and a tube through which the gas stream at least partly flows, whereby the tube is

at least partly porous to the gas stream and the apparatus additionally comprises means for collecting at least one pollutant.

Suitably, the tube is at least partly about the charging means. Suitably, the charging means comprises an electrode.

Suitably, the tube is perforated. Suitably, the tube comprises a plurality of holes therethrough. Suitably, the holes are evenly spaced. Suitably, the holes are evenly sized. Suitably, the perforated region of the tube is substantially annular. Suitably, the perforated region of the tube extends for a substantial length thereof.

Suitably, the tube comprises at least one slot therethrough. Suitably, a plurality of slots is provided. Suitably, the slots are substantially evenly distributed about the tube. Suitably, the at least one slot runs longitudinally along the tube.

Suitably, a major portion of the tube is porous. Alternatively a minor portion of the tube is porous.

Suitably, the tube is circular in cross-section. Suitably, the tube comprises an inlet and an outlet.

Suitably, the cross-sectional area of the tube decreases along its length from the input to the output thereof.

Suitably, the electrode is mounted at one end thereof only.

Suitably, there is a first gas flow path from an apparatus gas inlet to an apparatus gas outlet and a second gas flow path from the apparatus gas inlet to the apparatus gas outlet. The first and second gas flow paths may be in common for a part thereof. Suitably, a filter is located in the second gas flow path. Suitably, the tube is located in the first and second gas flow paths. The tube acts to split the gas flows and concentrate at least one pollutant in one flow path for subsequent removal.

Suitably, the system comprises a first expansion tube in fluid communication with an apparatus gas inlet. Suitably, the diverting tube extends from the first expansion tube to a second expansion tube defined by the tube. Suitably, there is a third expansion tube about the diverting tube into which gas can flow through the diverting tube. Suitably, a filter is located between (in respect of gas flow) the second and third expansion tubes.

Suitably, the filter comprises an electrically regenerative filter.

Suitably, the system is for removing pollutants from an exhaust gas stream, preferably a vehicle exhaust gas stream.

Suitably, the system is for use in an exhaust gas flow stream. Suitably, the system is for use in a vehicle exhaust gas flow stream, preferably a diesel exhaust.

Suitably, the electrode is for corona discharge ionisation of a gas flow stream.

Brief Description of the Drawings

The present invention will now be described, by way of example only, with reference to the drawings that follow; in which:

Figure 1 is a plan view of a first mounting body for mounting an electrode according to a first embodiment of the present invention.

Figure 2 is a plan view of a second mounting body for mounting an electrode according to a second embodiment of the present invention.

Figure 3 is an enlarged sectional view of Figure 1, the section being taken along a plane of the axis of the body of Figure 1.

Figure 4 is a cross-sectional view of a mounting body for mounting an electrode according to a third embodiment of the present invention.

Figure 5 is a cross-sectional schematic view of a particulate diversion apparatus according to an embodiment of the present invention.

Figure 6 is a schematic, perspective, partly cut-away view of the apparatus of Figure 5.

Figures 7-9 are cross-sectional schematic views similar to Figure 5 of second to fourth embodiments of the present invention.

Description of the Preferred Embodiments

Referring to Figure 1 of the drawings that follow, there is shown a plan view of an electrode mounting body 2, made from a ceramic, electrically substantially non-conducting material, here Alumina or SINTOX (trade mark).

The body 2 is substantially circular cylindrical and includes a cylindrical hole 4 (dashed lines) along the axis thereof through which an electrode 6 is to be mounted. The electrode 6 projects from a first end 8 of the body 2, which projecting portion of electrode 6 (see Figure 3) forms a corona discharge electrode in use. A second end 10 (opposite first end 8) of body 2 allows the electrode to be connected to a power source (not shown). It is noted that the electrode 6 is mounted from one end only. Thus the electrode 6 has a mounting end (second end 16) and an electrode projecting end (first end 8).

From the first end 8, the body 2 is initially generally circular cylindrical. The body 2 is then interrupted by three substantially similar protrusions 12a, 12b and 12c. The protrusions 12a, 12b and 12c are described in more detail in relation to Figure 3 below. The protrusions 12a, 12b and 12c are separated from one another and from the first end 8 of body 2.

After the protrusions 12a, 12b and 12c, the body 2 is again circular cylindrical until it reaches a shoulder 14 leading to an outwardly flared section 16 from which there is a first step 18 and a second step 20. The section of body 2 from shoulder 14 to second end 10 provides a structure for the body 2 to be held in a mounting bracket

(not shown) or the like. Typically, the mounting bracket will be of a hard anodised metallic material, typically aluminium. It is to the mounting bracket that the protrusions 12a, 12b and 12c discourage current flow.

The protrusions 12a, 12b and 12c are separated from the bracket mounting structure by a distance substantially greater than the distance from the protrusions to the first end 8. In this case the distance measured in each case to the most distant protrusion.

Figure 2 of the drawings that follow is an electrode mounting body substantially similar to that of Figure 1 except that it varies in the dimensions used.

Referring now to Figure 3 of the drawings that follow, there is shown an enlarged view of the section of electrode 2 incorporating the protrusions 12a, 12b, 12c. Only the protrusion 12a will be described in detail as the other protrusions 12b and 12c are substantially similar.

Considered from first end 8, protrusion 12a comprises an inverted cone 22 that tapers towards the first end 8 with an internally truncated hollow volume 24 whereby the path from the projecting portion of electrode 6 to earth is substantially increased and made significantly more tortuous.

The cones 22 form flared flanges, extending outwardly towards the electrode projecting first end 8 of the body 2.

The cone 22 forms a protrusion shoulder 26.

In this example the diameter of the hole 4 for the electrode 6 is about one-third of the diameter of body 2 (measured at a region and which the body 2 constantly is cylindrical). In this example the protrusion shoulders 26 protrude for about half of the diameter of the body 2 (measured at a region at which the body 2 is constantly cylindrical).

The external angle A of the cone 22 to the body 2 (where it is of constant diameter for a region) is 130°. The internal angle of the cone (between faces) is 16°.

The protrusions provide a tortuous conductivity pathway from the electrode reducing current loss.

The mounting arrangement described herein is preferably for a pollutant, preferably a particulate removal system in which a gas stream passes the charged electrode, which charges particulates in the gas stream which can then be separated from the gas stream by electrostatic separation. Such a system incorporating the mounting arrangement described above is described briefly with reference to Figure 4 of the drawings that follow.

Figure 4 show an alternative mounting arrangement embodiment in which similar reference numerals are used for like parts. The annular cones 22 are move inclined and further tapered than the embodiments of Figures 1-3. The diameters of the cones 22 may vary. Where the diameters vary, there will be an increase in diameter from the first end to the second end.

It will be appreciated that the number, spacing and shape of the protrusions may vary.

Referring to Figure 5 of the drawings that follow, there is shown an apparatus 102 for diverting pollutants, especially particulates from gas streams. The apparatus 102 is mounted in a vehicle exhaust (not shown), typically in a silencer thereof, through which inflowing exhaust gas enters at 104 and exits at 106.

The apparatus 102 comprises an outer body 108, typically of sheet steel. Within body 108 there is defined a first expansion chamber 110 defined by internal wall 112 leading to a perforated elongate tubular field tube 114 defining a chamber mounted to outer body 108 by internal walls 112 and 116.

The tube 114 comprises a tube inlet 118 in first expansion chamber 110 and a tube outlet 120 in a second expansion chamber 122 defined in part by internal wall 116. The tube 114 is circular cylindrical and its cross-sectional diameter decreases at a constant rate from the tube inlet 118 to the tube outlet 120. The tube 114 is perforated by a multiplicity of evenly sized and spaced circular holes from the tube inlet 118 to the intersection of tube 114 with internal wall 116. From internal wall 116 to tube outlet 120 the tube 114 is solid. A major proportion, around 80% of the tube 114 is holes in the perforated region thereof. The tube 114 is substantially porous to gas flow.

A third expansion chamber 124 is located about the perforated tube 114. Third expansion chamber 124 is

defined by internal walls 112 and 116. A further gas flow path is provided from third expansion chamber 124 to second expansion chamber 122 via filter 126 fitted to an outlet 128 in internal wall 116 of third expansion chamber 124. The filter 126 is an electrically regenerative filter such as that available from 3M under part number SK-1739. The filter 126 is wired for electrical regeneration though, for simplicity, this is not shown. The exhaust gas can pass to second expansion chamber 122 to apparatus outlet 106.

The electrode 6 is shown in the ceramic electrode holder body 2 and projects into tube 114 along the axis thereof for part of the length of the perforated section thereof. Electrode 6 projects into the part of tube 114 in third expansion chamber 124. Electrode 6 is connected to a high voltage power supply 134 by connection means 136.

It is noted that two gas flow paths are provided between gas inlet 106 and gas outlet 108. First 138 and second 140 gas flow paths 138 and 140 respectively are indicated by respective lines and arrow heads. First flow path 138 follows the following route: inlet 104, first expansion chamber 110, tube 114, second expansion chamber 122 to outlet 106. Second flow path 140 follows the following route: inlet 104, first expansion chamber 110, tube 114, third expansion chamber 124, filter 126, second expansion chamber 122 to outlet 106.

Figure 6 shows the apparatus 108 with the outer body 8 cut-away for clarity.

In use, the electrode 2 is charged to 40kV negative polarity. When vehicle exhaust gas enters the tube 114, a substantial proportion of particulates are ionised as they pass the electrode 2. Charged particulates are attracted to the floating earth perforated chamber wall 114. The momentum of the particulates and the acceleration acquired from their attraction to tube 114 generally causes them to pass through the perforated wall of tube 114. It can be said that the particulates are diverted into a second gas flow stream separate from the first gas flow stream. The filter 126 is in one of the gas flow streams only, here the second gas flow stream. Some of the exhaust gas exits tube outlet 120 following first flow path 138. However, a proportion of the exhaust gas follows second flow path 140 and helps convey the diverted particulates to filter 126. The exhaust gas then passes through filter 126 which collects particulates being conveyed to it by the exhaust gas.

Referring to Figures 7-9 of the drawings that follow, three further embodiments of the present invention are shown, similar to the Figures 5 & 6 embodiment except as set out below. In Figures 7-9 like reference numerals are used for parts similar to the Figures 5 & 6 embodiment.

In the Figure 7 embodiment the tube 114 is of substantially constant diameter instead of tapering downstream. The Figure 7 embodiment may not perform as well as the Figures 5 & 6 embodiment, though it is still believed to be an improvement out known proposals and may be easier to manufacture.

In the Figure 8 embodiment the perforations in tube 114 are replaced by four equally spaced longitudinal slots, of which three are visible (at least in part) 146a, 146b and 146c. The slots 146 are porous to gas flow, but only provide gaps through tube 114 for a minor proportion thereof. Thus, particulates diverted towards tube 114 are far less likely to pass therethrough. As a result the more pollutant concentrated gas flow tends to be along first flow path 138 in which, in this embodiment, filter 126 is located.

Additionally in Figure 8, a catalytic converter 148 is located in the second flow path 140, though it is noted that the apparatus 102 can function upstream and/or downstream of a catalytic converter.

Figure 8 also shows a further modification in which a perforated section of tube 114 extends to the mounting arrangement 150 of electrode 130.

The embodiment of Figure 9 operates in a manner substantially similar to that of the Figure 8 embodiment, except that a perforated section 152 of tube 114 is provided for a minor proportion thereof.

Thus both the Figure 8 and 9 embodiments provide gas porous regions only for a minor portion of tube 114.

It is noted that there may be a plurality of apparatus as described above in a gas flow path, in series or in parallel.

Although preferred embodiment are described above in relation to the diversion of particulates from an exhaust gas flow stream, the apparatus can be used to divert particulates in other gas flow streams. However, it is believed currently that the present invention is of particular benefit when used in an internal combustion engine exhaust gas flow.

Accordingly, embodiments of the present invention can divert particulates from a gas stream, the efficiency thereof being enhanced by providing a porous field tube, and with a particulate removal means, such as the filter described herein, can remove particulates from a gas stream.

The apparatus 102 may be placed upstream or downstream of an exhaust catalytic converter (not shown).

Instead of a d.c. voltage, high frequency a.c. may be usable.

The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination,

except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of the foregoing embodiment(s). The invention extend to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.